#00-01 (Jan-Feb 00)

# EUROGRAM

***EUROPEAN OFFICE OF AEROSPACE RESEARCH AND DEVELOPMENT***

## CC HIGHLIGHTS

Happy New Year to all our customers in the Air Force Research Laboratory! We look forward to an exciting and challenging year of international efforts.

We're changing our look and improving your access to us. The Eurogram will continue to be available electronically through our website (www.ehis.navy.mil), but the web page is being updated and you'll soon have much better capabilities for the current and past Eurograms. We'll keep you posted here and on the website as improvements are made. Give us your comments so we can continue to make the Eurogram a more useful tool.

And now for the headlines:

- U. of Surrey hosts successful mono-propellant hybrid rocket test firings
- AFRL team visits Russian laser contractors
- Latest from the Russian Hypersonics initiative
- Highlights from the 9th Israel Materials Engineering Conference
- Russian Energetic Materials contractors submit progress reports

For the Commander

Robert S. Fredell, Lt Col, USAF, Technical Director

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# PROGRAM MANAGER REPORTS

*Dr. Charbel Raffoul*
*Aeronautics*

**Site visit: Research Organizations in St. Petersburg and Moscow Russia [Russian Initiative], July 1999.** Under the Air Force Research Laboratory (AFRL) Third Millennium Initiative, advanced Russian technologies with application to high-speed flight vehicles are being investigated under an activity referred to as the Russian Initiative. Representatives of The Johns Hopkins University, Applied Physics Laboratory (JHU/APL), AFRL, AFOSR, and EOARD traveled to St. Petersburg and Moscow to hold discussions at various Russian institutes on these advanced aerospace technologies. At each site, proposals for future Russian initiative work in high-speed flow control, combustion, and diagnostics were specifically solicited. To the maximum possible extent, future contracts under the Russian Initiative will be administered through the International Science and Technology Center (ISTC). There are many advantages to using ISTC, as described by Dr. Roy Phillips in the November-December 1999 issue of the Eurogram.

A brief summary of trip highlights:

- The **Ioffe Physical Technical Institute** reviewed the activities being conducted under sub-contract to JHU/APL in the field of Magnetohydrodynamic (MHD) control of supersonic inlet flowfields. The combined computational and experimental program is making good progress with 2D and 3D MHD codes developed in preliminary form, and a MHD/inlet model built and installed in a shock tunnel. Testing is now getting underway, and the first two interim reports summarizing progress are available.

- The **Leninetz Holding Company** presented their work concerning steam reforming fuels, MHD flow control, and plasma aerodynamics. The delegation also visited the State Institute for Applied Chemistry to review work being conducted by Leninetz under EOARD sponsorship on a methane-steam forming process. During the visit, a steam/methane reactor demonstration test was successfully conducted. The company continues to explore the so-called AJAX (hypersonic plasma) technologies.

- **Moscow State University** (MSU) discussed their work for JHU/APL studying transverse and microwave discharges in supersonic crossflows with application to advanced scramjet fuel injection and ignition systems. MSU has made significant progress in this experimental program with detailed measurements made of both types of discharges in air. They are currently extending this work to fuel-air mixtures. The first progress report on their activity is now available. MSU has also been looking at other applications of gas-discharge physics including treating surfaces, reducing sonic booms, minimizing acoustic signatures, etc. MSU has again proposed an alliance with JHU in the general area of gas discharge physics.

- Discussions were held with the **Central Institute of Aviation Motors** (CIAM) and **Moscow Technical Company** (MTC) on the application of novel plasma injectors and other plasma generation devices for scramjet combustion applications. MTC/CIAM will refine their proposal and provide cost estimates and statements of work for this activity.

  The APL-funded endothermic fuel reactor activity at CIAM was reviewed. The full-scale

reactor has been completed and testing has been conducted on a partial reactor. The reactor will be shipped to APL in October.

While visiting, the Director of CIAM presented Paul Waltrup (APL) with the prestigious Bondarjuk Medal for his contributions to the field of ramjets and scramjets. This medal, named after M. M. Bondarjuk the noted Russian scientist and ramjet developer, was founded by the Russian Academy of Science (RAS) and the Russian Federation of Airsport (RFAS) in 1998. Don Stull and Tom Curran of AFRL/PR (not present) were also awarded the medal.

Meetings with Moscow Technical Company personnel revealed they had recently prepared a summary report on the characteristics of electromagnetic wave propagation through various types of plasma with application to signature control. This report was prepared for a non-U.S. customer.

The U.S. group also visited the High Temperature Institute of the Russian Academy of Sciences (IVTAN) (a first). MTC personnel have established themselves at this institute and have reconstructed their labs at this site. Experimental set-ups allow study of the effects of plasma on shock propagation, aeroacoustics, fuel injection and ignition. Interesting results on shock attenuation and injector super-penetration are being obtained. The first two progress reports, which detail their activity on the shock propagation work, are now available from EOARD. IVTAN personnel also discussed and showed evidence of an eight-minute scramjet combustor test that had been conducted by CIAM.

V. I. Penzin provided a draft of a new report summarizing his scramjet experience.

- A portion of the 7th International Workshop on the Physics of Compressible Turbulent Mixing was attended and it was found that a significant technical community exists within the DOE/nuclear industry that is working on instabilities, turbulence, and compressible mixing. The basic technologies under investigation overlap with those investigated by the aerospace community, so future collaborations and information exchanges should be pursued.

The general state of the institutes and cities in general were much improved from our last visit. It was clear that some of the institutes we visited have started to turn things around.

**Site Visit: Department of Mechanical Engineering, University of Bath, UK, February 1999.** The University of Bath has firmly established itself as one of the best universities in the UK. It was recently ranked sixth out of 191, the highest outside Oxford, Cambridge, and London. Their research portfolio now amounts to $50M, with broad-based UK and European funding.

The Department of Mechanical Engineering (ME) at Bath is one of only five ME departments in the country to be given the highest possible 5-star rating in the recent Funding Councils' Research Assessment Exercise. The Department has also been awarded an excellent rating in the latest assessment of quality in teaching and learning. The Department is divided into six groups:

- Manufacturing & Materials;
- Aerospace Engineering;
- Thermofluids;
- Design; Structures & Biomechanics;
- Systems, Control & Applied Mechanics; and
- Center for Power Transmission & Motion Control.

Within the Aerospace Engineering Group, active research areas include unsteady aerodynamics of vortex flows over fighter aircraft, fin buffeting,

aerodynamic flow control, Micro Air Vehicles, flow-induced vibrations, aeroacoustics, and gas turbine cooling systems. Buffeting and vortex-dominated flows are particular strengths of the Group. Interaction of leading-edge vortices with flexible fins and active and passive control of fin buffeting are among the ongoing research projects. The major Aerodynamics Laboratory facilities include six wind tunnels, a water tunnel, a towing tank, and a rotating-disc rig. These facilities have comprehensive instrumentation suites including a high-power Argon laser for flow visualization, infrared thermal-imaging equipment, and data acquisition systems supported by approximately fifty Silicon Graphics and Sun workstations.

**Note:** The ME Dept. currently has a contract with EOARD on "Interaction of Vortex Breakdown with a Flexible Fin and its control." Prof. Ismet Gursul is investigating fin buffeting caused by vortex breakdown and its control. In the first phase, flow visualization and velocity measurements will be used to investigate the effect of fin deflections on vortex breakdown.

**Conference: Parallel CFD Workshop; Experiences in Implementation, Istanbul Technical University, Turkey, 16-18 June 1999.**

More than forty researchers from seven countries gathered at the Istanbul Technical University Macka Campus to exchange their experiences and to present their most recent research in the very popular topic of "Parallel Computational Fluid Dynamics" within the framework of an Academic Agreement signed between Istanbul Technical University (ITU) and a group of universities in Indiana (IUPUI). The Workshop was organized by Profs. U. Gulcat of ITU and A. Ecer of IUPUI. The theme / scope of the workshop was a review of different experiences in providing parallel algorithms for everyday use. There were several invited keynote lectures and one special lecture, "Usage of the New OpenMP Standard on Parallelization." delivered by I. Zacharov of SGI.

The invited lectures related to Performance Comparisons, Tools and Environments, Parallel Algorithms, Applications and Domain Decomposition Aspects of Parallel CFD. They included "Efficient Parallelization of an Unstructured Grid Solver: A Memory Centric Approach" (D. Kaushik and D. E. Keyes), "Explicit Multi-Grid Acceleration Methods for the Solution of N-S Equations" (M. Meinke and E. Krause), "Issues for Large Scale Simulations in the Process Industries" (D. R. Emerson and R. J. Blake), "Efficiency Studies of a Parallel Substructuring Algorithm on Different Platforms" (H. U. Akay and S. Kocak) and "Some Domain Decomposition and Parallel Algorithm Issues for the Numerical Simulation of a Catalytic Reactor TAP2" (M. Garbey).

The 13 contributed talks covered a wide range of CFD problems solved with high performance computing means from Cache Based Machines to PC Clusters. Of particular interest was the presentation "Parallelization of a 3-D Flow Solver with Special Respect to the Parallel Equation Solver" made by T. Boenisch (HPCC, Stuttgart). Mr. Boenisch discussed the parallelization of the Jacobi line relaxation solver in conjunction with the usage of the additional splitting method in reducing the coupling between the matrix parts located on different processors. With this, the speed-up and the scale-up performances on the massively parallel computers become very high for the solution of 3-D Euler and N-S Equations to study suporsonic flows past re-entering space vehicles in a wide altitude-velocity range. Another presentation of interest from ITU was "Reducing Parallelization Overheads for Incompressible Flows Using Pseudo-Second-Order Velocity Interpolations." This work dealt with increasing the computational efficiency of an incompressible flow solver to the super linear levels with reducing the computational complexity of implicit pressure solver. The N-S solver of this study was developed and tested using PVM on workstation clusters running on Linux. A. Ecer's (IUPUI) presentation "Software, Hardware and Algorithm

Considerations in Reducing Communication Cost for Parallel Computing" emphasized how to reduce communication costs for solving the 3-D heat equation and the Navier-Stokes Equations on Workstation Clusters running on Unix or NT.

Abstracts and full proceedings are available from EOARD.

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*Major Jerry J. Sellers*
*Astronautics*

**Conference: 9th Israel Materials Engineering Conference, Technion, Haifa, Israel, 6-7 December 1999.** This two-day conference primarily hosted Israeli researchers but also included participants from throughout the world including Germany, Romania, Switzerland, Canada, and the United States. Captain Matt Yocum, USAF Academy, (scheduled to be the first USAF ESEP in Israel beginning later this year) attended and contributed to this report. Plenary session topics included the future of semiconductors, applications of quasi-periodic materials, tailoring of polymer composites, and materials for the electronic industry. The conference was organized into several parallel sessions in the areas of Coatings & Surface Treatments, Semi-conductors, Advanced Silicon Device Processing, Mechanical Behavior, Non-structural Materials, Smart & Functionally Graded Materials, Corrosion and its Inhibition, Bio-Materials, Simulation & Modeling, and Intelligent Processing of Plastics.

Of specific interest:

- The plenary session on materials for the electronic industry highlighted the importance of materials science problems that must be solved in order to continue the progression of electronics industry advancements, both evolutionary and revolutionary.
- Dr. A. Buchman from Rafael, Israel presented on-going work on using conventional microwave oven technology to cure adhesive bonds. AFRL/ML is involved with this program.
- A presentation in mechanical behavior included a non-linear dynamical (using chaos theory) analysis of a crack surface in sapphire. The research indicated the governing equation of motion for the crack growth is a differential equation with a minimum of seven independent dynamical variables. Following the path of a crack may seem random, but through this research, it appears there may be order (deterministic and chaotic) to the apparent random path a crack takes.
- Dr. Dov Sherman from Technion, partly supported by an EOARD contract, is conducting this work. His effort titled "Ceramic/Metal Laminate For Application Involving High and Rapid Thermal Gradients" deals with the mechanical behavior of ceramic-metal laminate under thermal shock. During the conference, we also had the opportunity to tour Dr. Sherman's lab and discuss his work at length. For additional information about materials research at Technion visit their website (http://www.technion.ac.il/ technion/materials/)

This conference provided a wealth of information on where the world in general and Israel in particular is heading in the realm of materials science and engineering. For more information, visit the conference website (http://www.technion.ac.il/technion/materials/imec9/), or contact Major Sellers.

**Site Visit: IARD - Institute for Advanced Research and Development, Haifa, Israel, 8 December 1999**. Dr. Adam Devir is a well known expert in the fields of Atmospheric Optics, Radiometry, IR Physics & Electro-Optics. He has completed 3 previous contracts managed by EOARD in these areas. Most recently his in situ measurements have proved valuable in correlating and updating atmospheric transmission codes. The purpose of the meeting was to discuss his latest proposal: "Comparison of Atmospheric Transmittance Measurements in the 0.4-0.7micro-

m, 1.3-5.5micro-m and 8-12micro-m Spectral Regions with MODTRAN: Considerations for long path geometries applicable for Theatre Defense." EOARD is currently working with AFRL/VS and BMDO to secure funding for this effort for possible start in 2000.

**Site Visit: Ben-Gurion University of the Negev, Department of Electrical and Computer Engineering, Beer-Shiva, Israel, 9 December 1999.** Dr. Norm Kopeika of the Electro-optics Laboratory has done pioneering work in remote sensing, specifically in the area of atmospheric turbulance on optical transmission. In late 1998, Dr. Kopeika completed a 2-year AFRL-funded effort managed by EOARD titled "Prediction of Optical Turbulence in the Stratosphere." During the visit, Dr. Kopeika gave an extensive tour of his lab and facilities and the on-going research in his department. As part of the AFRL contract, Dr. Kopeika has established a state-of-the-art capability to take measurements of atmospheric turbulence effects. His team is also doing extensive work in the areas of:

- Restoration of images from atmospheric blur,
- Optics of the stratosphere,
- Satellite optical communication,
- Image motion and vibrational blur
- Restoration from Image motion and vibrational blur,
- Real-time restoration of live TV imagery.

I also met with Dr. H. Guterman from the Neural Network and Fuzzy Logic Laboratory. His research team is involved with applying these computational tools to automatic target recognition, bio imaging, and image processing. For additional information on research in this department and at the University, visit their website (http://www.ee.bgu.ac.il/)

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*Dr. Martin Stickley*
*Lasers, Optics and Materials*

**Site Visits: Organizations in Samara and Moscow, Russia, 4-9 October 1999**. An AFRL team composed of Col. Greg Schneider, Dr. Harro Ackermann, and Dr. Gordon Hager of AFRL/DEL, and Col. Gerald O'Connor and Dr. Martin Stickley, EOARD, visited contractors in Samara and Moscow, Russia to assess progress on EOARD contract research.

1) The Samara, Russia group (P. N. Lebedev Physical Institute of the Russian Academy of Sciences, Samara Branch, Samara, Russia; POC:Dr V. Nikolaev, nikolaev@fian.samara.ru) has been under contract to the Air Force through EOARD for almost three years. The Samara laser device at the beginning of the contract had a maximum flow rate of 10 millimoles of $Cl_2$ per second, because of a facility pumping limitation. Under contract, the Samara group upgraded their facility and the laser device hardware to a capability for testing at flow rates up to 100 millimoles of chlorine per second. During the initial phases of the work the Samara group conducted a number of parametric studies using their small scale (10 millimoles per second $Cl_2$) jet singlet oxygen-driven COIL device. These included parametric variations in the stoichometry of the basic hydrogen peroxide (BHP), temperature variations in the BHP, and laser power and small signal gain by varying the resonator mirror reflectivities. More recently with the increased flow rate capability, the Samara group has been successful in demonstrating a scaleable (two dimensions) vertical COIL with a jet singlet oxygen generator; 858 watts with a chemical efficiency of 24.1% was achieved.

The most significant result, however, was the demonstration of an advanced nozzle concept that achieves 100 torr pressure recovery with high chemical efficiency (~20%). This concept integrates a high Mach number (Mach 4) nitrogen ejector nozzle with a Mach 1 oxygen stream. Molecular $I_2$ is injected at the nozzle exit plane into the Mach 1 oxygen stream where rapid $I_2$ dissociation occurs. Fast, turbulent mixing occurs

due to the shear forces generated by the velocity-mismatched flows. The nitrogen flows energize the oxygen resulting in a pressure recovery potential to 100 torr.

The Samara Group has installed a RF discharge (10–30 megahertz) in the cavity of their supersonic nozzle. The discharge can run pulsed or CW, and will be used to liberate iodine atoms from premixed flows of $0_2$ ($^1\Delta$) and $CH_3I$. This is an alternative way to produce iodine atoms in the COIL laser. If this concept proves to be successful it may eliminate mixing nozzles because $CH_3I$ and $0_2(^1\Delta)$ do not react and can be premixed.

2) The Troitsk COIL group (Troitsk Institute for Innovation and Fusion Research, Troitsk, Moscow Region, Russia; POC: Dr. Nikolai Yuryshev (yuryshev@x4u.lpi.ruhep.ru) is using different electric discharge configurations to produce iodine atoms. With a longitudinal pulsed discharge configuration in a subsonic COIL, they have achieved a ratio of peak to CW power of 300 with 10% chemical efficiency. The technical challenge is now to develop discharge geometries that are transverse to the flow. This type of configuration is amenable to high pulse repetition rate supersonic operation.

3) The General Physics Institute (GPI, Laser Materials and Technology Research Center of the General Physics Institute of the Russian Academy of Sciences, Moscow; POCs: Academician V. V. Osiko, osiko@ftt.gpi.ru and Prof. T. T. Basiev, basiev@lst.gpi.ru) has EOARD contracts to develop materials for 1.3 micron Raman shifters, materials for 2 - 5 micron directly pumped solid-state lasers, and a tunable solid-state color center laser operable between 1 and 2 microns. New Raman converters for 1.3, 1.06, and 0.532 micron lasers with nano- and picosecond pulse durations have been developed using a new crystalline material, $BaWO_4$, having an excellent combination of high Raman cross-sections (peak and integrated), and high nonlinear and thermophysical properties. The effort to develop mid-IR solid-state laser materials has initially concentrated on understanding multi-phonon relaxation rates in candidate materials including fluorides, chlorides, and bromides, as these rates determine the lifetime of the upper laser level and the depopulation rate of the lower laser level. A long upper state lifetime and a short lower level lifetime is desired for an efficient laser. The tunable color center laser is to be delivered to the AFRL upon its completion. The device will be used to optically pump gas lasers operating between 3 and 5 microns.

4) Lebedev Physical Institute (of the Russian Academy of Sciences, Moscow, Russia, POCs: Academician N. G. Basov, Dr. Andrei Ionin, aion@sci.lebedev.ru and Dr. Anatoli Napartovich) presented a review of the carbon monoxide overtone laser program. The goals of the program are to develop an efficient device that operates on the CO overtone transitions, ($\Delta V = 2$), in the mid-IR. The key result of the program had been a demonstration of 11% efficiency on the multiple overtone transitions. This laser has also been grating-tuned with single line efficiencies of ~1% on approximately five hundred lines between 2.5 and 4.2 microns. The experimental work so far has been conducted on electron beam-sustained discharge devices. Work in the future will shift to RF excitation. An additional thrust of the effort is to develop a comprehensive theoretical model capable of explaining and organizing the experimental results. This model is expected to be delivered to the AFRL within the next year.

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*Mr. Jay Howland*
*Physics and Energetic Materials*

**Contract Progress Reports: Energetic Materials - Irkutsk Institute of Chemistry, Irkutsk, Russia and St. Petersburg State Institute of Technology, St. Petersburg, Russia.** EOARD funds several contracts in Russia performing fundamental investigations of structure/reactivity and structure/energetic

property relationships leading to the synthesis of improved energetic compounds. Five of these contracts recently delivered progress reports.

1) Prof. Alevtina S. Medbedeva (Irkutsk Institute of Chemistry) is working on the **synthesis and characterization of unique cyclic azidonitramines**. The quest for optimal combinations of high explosive power and thermal stability is an important problem in the synthesis of new potentially highly effective energetic compounds. Energetic cyclic polynitramines, the most widely used of which are HMX and RDX, are thermally stable explosives. The azido group produces high-energy molecules due to its high heat of formation. Organic azides possess sensitivity to mechanical actions such as impact and friction. The construction of this kind of polyfunctional compound as well as modification of highly energetic compounds is a complicated problem.

2) Dr. Maria M. Demina (Irkutsk Institute of Chemistry) is working on the **synthesis and characterization of tricyclic condensed azido triazoles**. Azides and heterocylic compounds represent new prospective classes of energetic compounds. The principal object of this research into new energetic materials is the synthesis of new compounds with suitable energetic characteristics involving enhanced thermal and chemical stability and low sensitivity to impact and shock. Since azides possess insufficient stability the goal is the synthesis of tricyclic condensed azido triazoles that potentially have both stability and high density.

3) Prof. Igor V. Tselinskii (St Petersburg State Institute of Technology) is working on the development of safe, effective and environmentally benign methods of **synthesis of energetic vinyl monomers** in the series of 1,2,4-triazole and tetrazole. Development of energetic polymer binders of various formulations of solid rocket propellants, high explosives and gas generating systems becomes a central problem of research in these areas. Polymers containing azido moieties have long been the subject of studies in the USA, Russia and other countries. However, these energetic polymers do not always meet requirements for such components due to thermal stability, explosion hazards, thermodynamic compatibility with fillers, toxicity, etc. Therefore other vinyl monomers for preparing energetic polymers are being studied.

4) Dr. Svetlana F. Mel'nikova (St Petersburg State Institute of Technology) is working on the **synthesis and characterization of novel energetic compounds** on the basis of unsymmetrically substituted 1,2,5-oxadiazole derivatives. Analysis of available publications on the synthesis of 1,2,5-oxadiazoles (furazan) derivatives has shown that the most promising initial reagents for preparation of new energetic 1,2,5-oxadiazoles are 3-aminofurazans. The possibilities of synthesis of other novel energetic derivatives are being studied.

5) Dr. Emma L. Metelkina (St Petersburg State Institute of Technology) is working on the **synthesis of hydrazonitroformamidine** (1,6-dinitrobiguanidine) on the base of 2-nitroguanidine. According to published reports, the manner of interaction between 2-nitroguanidine and its derivatives and hydrazinehydrate depends on both reaction conditions and nature of constituents in the starting reactants. To define the effect of the constituents in the 2-nitroguanidine molecule upon the reaction, the contract is studying the interaction of the series of 2-nitroguanidine derivatives with other reactants.

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*Major Tim Lawrence*
*Space Technology*

**Presentation: Electric propulsion (EP) space experiments, Marriott Hotel, Norfolk, VA, 4 Nov 99.** AFOSR sponsored the Space Plume Diagnostics Workshop in conjunction with a larger conference on hypersonics. The primary host and

POC was Mitat Birkin. There were 18 attendees, including 2 Russian nationals, who all gave presentations on their research. The purpose of the workshop was threefold:

- to discuss on-going research in electric propulsion,
- identify the key issues as these systems are ground-tested, and
- determine what data are needed to qualify electric propulsion systems for space.

The need to recover the maximum possible flight test data from the 100 Russian EP flight tests was highlighted. These data were determined to be critical to establishing realistic ground experiments for future missions. EOARD will identify the appropriate agencies in Russia that can help in this area.

**Meeting: Cryo-cooler vibration damping, Oxford, United Kingdom, 9 Dec 99.** Oxford University's Dr. Gordon Davy reviewed the progress of his AFRL-funded vibration damping work with Dr Thom Davis of AFRL/VS. Dr Paul Baily presented the latest results in their development to produce four balanced compressors. Their theory is that balanced compressors in the cryo-cooler will reduce vibration to low enough levels that expensive vibration electronics will not be needed. Oxford is in the process of reducing the variability in the manufacturing of each compressor and hope to have data with conclusions by June 2000.

**Site Visit: Test firings of nitrous oxide mono-propellant and hybrid systems, University of Surrey, Westcott Test Site, United Kingdom, 10 Dec 99.** Mr. Malcolm Paul hosted the latest tests in Surrey's EOARD-funded investigation of nitrous oxide mono-propellant and hydrogen peroxide/polythene hybrid rocket programs. These tests proved their ability to start decomposition of the nitrous oxide propellant at low temperatures ($100^{o}$C) and very low input powers and flow rates (16 W and 0.2 g/s, respectively). This research may enable future low-cost, non-toxic propulsion systems for microsatellites. In the area of hybrid firings, Surrey employs a novel fuel grain geometry - a pancake of 2 discs fueled together with radial oxidizer injection. The researchers conducted 14 firings for a total burn time of 70 seconds using Perspex as the fuel and gaseous oxygen as the oxidizer. The system demonstrated a sea level specific impulse of 205 sec at a thrust of 27 N showing promise for future small satellite propulsion missions.

## CONFERENCE SUPPORT

EOARD promotes technical interchange by supporting and co-sponsoring technical workshops and mini-symposia at overseas conferences. We often receive in return proceedings and attendance for one or more Air Force representatives. Air Force R&D personnel attending or considering attending European conferences should contact EOARD for further information. For further details on the conferences below contact the program manager indicated (see footnotes). **Bi-service and tri-service support efforts are in bold print.**

| *Dates (2000)* | *Location* | *Conference/Workshop Title* | *LO[1]* |
|---|---|---|---|
| 11 - 13 Jan 00 | Durban, South Africa | Third International Conference on Composite Science and Technology (ICCST/3) http://www.und.ac.za/und/mech/conference.html | JJS |
| 28 Feb - 3 Mar 00 | Zurich, SW | 3rd Intl. Conference on Flow Interaction (SCART 2000) | CNR |
| 9 Apr 00 | Davos, Congress Centre, Switzerland | AP2000 Millennium Conference on Antennas and Propagation http://www.estec.esa.nl/CONFANNOUN/AP2000/ | GTO |
| **17 - 19 Apr 00** | **Berlin, Germany** | **Third International Micro Materials Conference and Exhibition** www.micromaterials.com | **RSF** |
| 30 May - 2 Jun 00 | Edinburgh Int'l Conference Centre, Scotland | EUROEM 2000 | CMS |
| 30 May 00 | Vienna, Austria | Comparative & Veterinary Electrophysiology of Vision | RSF |
| 31 May - 2 Jun 00 | Stuttgart, Germany | Workshop on Thermal and Environmental Barrier Coatings | RSF |
| **26 - 28 Jun 00** | **Cambridge University,** | **Materials Engineering - a Forward Look (The Ashby Symposium)** | **RSF** |

| *Dates (2000)* | *Location* | *Conference/Workshop Title* | *LO*[1] |
|---|---|---|---|
| | **Cambridge UK** | | |
| 27 - 31 Aug 00 | Groningen, The Netherlands | European Conference on Visual Perception http://www.ecvp.org | GTO |
| 27 - 29 Sep 00 | Amsterdam | How eye movements serve the needs of vision in the natural world | GTO |
| 2 - 6 Oct 00 | Crimea, Ukraine | Singular Optics: Fundamentals & Applications | CMS |

[1] CMS-Martin Stickley; CNR-Charbel N. Raffoul; GTO-Gerald T. O'Connor; JAH-Jay A. Howland; JJS-Jerry J. Sellers; RSF- Robert S. Fredell;TL-Tim Lawrence

# WINDOW ON SCIENCE

EOARD initiates and promotes technical liaison between Air Force and foreign scientists very effectively with the Window On Science (WOS) program, through which we can arrange and fund visits of foreign scientists to selected Air Force facilities. To nominate a WOS candidate, contact your Technical Director or your EOARD discipline representative. WOS visitors currently on contract are listed below. For further details contact the program manager indicated (see footnotes). **Bi-service and tri-service coordinated visits are in bold print.**

| *Dates (1999)* | *Traveler* | *Country* | *Topic* | *Location(s) of US Visit*[1] | *LO*[2] |
|---|---|---|---|---|---|
| **8 - 22 Jan 00** | **Dr. Valentin Bityurin** | **Russia** | **Plasma Aerodynamics** | **Reno; NASA Ames; Tullahoma; AFRL/WPAFB** | **CNR** |
| 8 - 14 Jan 00 | Dr. Georgy Karabadzhak | Russia | Space Based Double Channel Imaging Sensor | attend AIAA 38th Aerospace Conference 10-13 Jan 00 | JAH |
| 8 - 14 Jan 00 | Dr. Yury Plastinin | Russia | Space Based Double Channel Imaging Sensor | attend AIAA 38th Aerospace Conference 10-13 Jan 00 | JAH |
| **8 - 14 Jan 00** | **Dr. Ismet Gursul** | **United Kingdom** | **Fin Buffetting** | **AIAA-Reno Hilton** | **CNR** |
| **9 - 22 Jan 00** | **Dr Vincent G Couaillier** | **France** | **Computational Fluid Dynamics; Aeroacoustics** | **AIAA-Reno; AFRL/Dayton, NASA Glenn; Allison/Indianapolis** | **CNR** |
| 9 - 19 Jan 00 | Professor Alexander B. Lessin | Israel | Dual Mode Sensor Capabilities | Attend the AIAA 38th Aerospace Conference 10-14 Jan 00 at Reno, Nv then meeting with BMDO 17-18 Jan 00 Washington DC | JAH |
| 9 - 22 Jan 00 | Professor Anatoly Kharitonov | Russia | Hypersonic Wind Tunnel | AIAA Aerospace Meeting Reno NV, Boeing Long Beach, NASA LaRC | PJO |
| 9 - 16 Jan 00 | Dr. Nikolay Zheludev | United Kingdom | Nonlinear optics of confined, liquid gallium | Tucson, AZ and USAFA, Colorado Springs, CO | CMS |
| 19 - 23 Jan 00 | Dr. R Peter Lindstedt | United Kingdom | Combustion & Detonation | NASA GRC, AFRL/WPAFB | CNR |
| 20 - 29 Jan 00 | Professor Michael Lewis | United Kingdom | Ceramic materials research | AFRL/MLLN, Wright-Patterson AFB OH, Conf. On Engineering Ceramics, Cocoa Beach FL | RSF |
| 21 Jan - 2 Feb 00 | Dr. Vitali Grouzdev | Russia | Ultrafast laser interaction with solids. | AFRL/DEOB, Kirtland AFB, NM | CMS |
| 21 Jan - 12 Feb 00 | Mr. Tilmann Heil | Germany | Nonlinear dynamical behavior of diode lasers | AFRL/DELO, Kirtland AFB, NM. | CMS |
| 21 Jan - 1 Feb 00 | Professor Jacques Lamon | France | Thermomechanical behavior ceramic composite mat'ls | Conference on Engineering Ceramics, Cocoa Beach FL; AFRL/MLLN, Wright-Patterson AFB OH | RSF |
| 29 Jan - 4 Feb 00 | Dr Chris Van Den Broeck | Belgium | | STAIF, Albuquerque, NM | PJO |
| 29 Jan - 2 Feb 00 | Dr Craig Underwood | United Kingdom | Microsatellites | USAF Academy, CO | JJS |
| 29 Jan - 5 Feb 00 | Dr David Fearn | United Kingdom | Advanced Ion Engine Presentation to STAIF-OO Conference | STAIF, Albuquerque, NM | TL |
| 29 Jan - 4 Feb 00 | Dr Martin Tajmar | Austria | Breakthrough Propulsion Physics | STAIF, Albuquerque | PJO |
| 29 Jan - 5 Feb 00 | Dr Sergui Krasnikov | Russia | Brief Staif-00 Conference on Breakthrough Propulsion Concept | Albuquerque, NM | TL |
| 29 Jan - 5 Feb 00 | Dr Andrei Goulevitch | Russia | Breakthrough Propulsion Research | Albuquerque, NM | TL |
| 5 - 13 Feb 00 | Dr. Frantisek Farnik | Czech Republic | Space Environment research using the HSRX instrument | Vandenberg, AFB, CA | JJS |
| 2 - 7 Apr 00 | Professor Ian Postlethwaithe | United Kingdom | Control Design | NASA GRC | PJO |
| 2 - 7 Apr 00 | Dr Declan Bates | | Control Design | NASA GRC | PJO |
| 3 - 8 Apr 00 | Mrs. Nataliya Antonova | Ukraine | Structure and properties of the Ti-Al-Ga alloys and the phase diagram of the Ti-Ga system | 13th Int. Conf. on Solid Compounds of Transition Elements - SCTE2000<br><br>Stresa Italy | RSF |
| 24 - 28 Apr 00 | Dr. Mireille Florence Levy | United Kingdom | EM Low grazing | | BTM |
| 25 Apr - 5 May 00 | Professor Richard Geoffrey Carter | United Kingdom | Vacuum Electronics | University of Wisconsin, Monterey Tube Conference | BTM |
| 27 Apr - 2 May 00 | Professor Iwan Prys Williams | United Kingdom | Meteors and interplanetary dust | AFRL/VSBS, Hanscom AFB, MA | CMS |
| 13 - 20 May 00 | Dr. Luigi Foschini | Italy | Meteoroid hazard to satellites | AFRL/VS, Hanscom AFB, MA | CMS |
| 19 - 29 Jun 00 | Professor John Plane | United Kingdom | The impact of extra-terrestrial dust on the upper atmosphere | AFRL/VS, HRS | CMS |
| 30 Jul - 10 Aug 00 | Dr. Adrian Stern | Israel | Restoring images degraded by motion | AFRL/DEBS, Kirtland AFB, NM., and San Diego, CA. | CMS |
| **19 - 24 Aug 00** | **Professor Ivor Smith** | **United Kingdom** | **Boundary Layer Transition & Turbomachinery Flows** | **Minnowbrook, NY** | **CNR** |
| **19 - 24 Aug 00** | **Professor Torsten H Fransson** | **Sweden** | **Boundary Layer Transition & Turbomachinery Flows** | **Minnowbrook, NY** | **CNR** |
| **19 - 24 Aug 00** | **Dr. Howard Hodson** | **United Kingdom** | **Boundary Layer Transition & Turbomachinery Flows** | **Minnowbrook, NY** | **CNR** |

| *Dates (1999)* | *Traveler* | *Country* | *Topic* | *Location(s) of US Visit*[1] | *LO*[2] |
|---|---|---|---|---|---|
| **19 - 24 Aug 00** | **Dr. Anthony Mark Savill** | **United Kingdom** | **Boundary Layer Transition & Turbomachinery Flows** | **Minnowbrook, NY** | **CNR** |
| **19 - 24 Aug 00** | **Professor Jonathan Gostelow** | **United Kingdom** | **Boundary Layer Transition & Turbomachinery Flows** | **Minnowbrook, NY** | **CNR** |
| **19 - 24 Aug 00** | **Professor Neil Sandham** | **United Kingdom** | **Boundary Layer Transition & Turbomachinery Flows** | **Minnowbrook, NY** | **CNR** |
| **19 - 24 Aug 00** | **Dr. Mark Wyatt Johnson** | **United Kingdom** | **Boundary Layer Transition & Turbomachinery Flows** | **Minnowbrook, NY** | **CNR** |
| **19 - 24 Aug 00** | **Prof. Erik Dick** | **Belgium** | **Boundary Layer Transition & Turbomachinery Flows** | **Minnowbrook, NY** | **CNR** |
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| **19 - 24 Aug 00** | **Prof. Ian Poll** | **United Kingdom** | **Boundary Layer Transition & Turbomachinery Flows** | **Minnowbrook, NY** | **CNR** |
| **19 - 24 Aug 00** | **Prof. Ulrich Rist** | **Germany** | **Boundary Layer Transition & Turbomachinery Flows** | **Minnowbrook, NY** | **CNR** |
| **19 - 24 Aug 00** | **Professor Michael Gaster** | **United Kingdom** | **Boundary Layer Transition & Turbomachinery Flows** | **Minnowbrook, NY** | **CNR** |
| 10 - 23 Sep 00 | Professor Alexey Ustinov | Germany | Applied Superconductivity | HRS, MIT, NRL, Applied Superconductivity Conference, Virgina Beach | BTM |

[1] AFRL Research Sites–**ARS**: Armstrong Research Site, Brooks AFB, TX; **ERS**, Edwards Research Site, Edwards AFB, CA **HRS**: Hanscom Research Site, Hanscom AFB, MA; **PRS**: Philips Research Site, Kirtland AFB, NM; **RRS**, Rome Research Site, Rome, NY; **WRS**: Wright Research Site, Wright-Patterson AFB, OH; Other sites: **AEDC**: Arnold Engineering Development Center, Arnold AFB, TN; **USAFA**: Air Force Academy, Colorado Springs, CO; **ARL**: Army Research Laboratory

[2] CMS-Martin Stickley; CNR-Charbel N. Raffoul; GTO-Gerald T. O'Connor; JAH-Jay A. Howland; JJS-Jerry J. Sellers; RSF-Robert S. Fredell; TL-Tim Lawrence

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